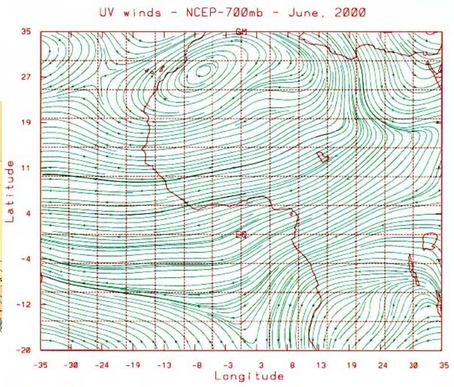
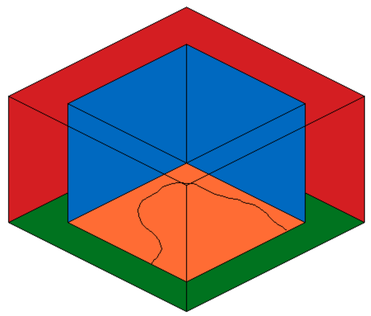
Mining observational data from the African Monsoon Multidisciplinary Analysis to optimize and validate climate model simulations

ABSTRACT

The RM3 Regional Model at the NASA Goddard Institute for Space Studies is configured to simulate the climate of West Africa. Using the larger, lower-resolution Global Climate Model and the NCEP (National Center for Environmental Prediction) reanalysis data for boundary conditions, the RM3 interprets the information and produces a higher resolution distribution of data points with 0.5° (50km) spacing. However, in order to optimize the accuracy of the model, it must be assessed through validation against observations. From atmospheric observation programs instituted by AMMA (African Monsoon Multidisciplinary Analysis) and NAMMA (NASA African Monsoon Multidisciplinary Analysis) as well as from satellites such as the TRMM (Tropical Rainfall Measuring Mission), MODIS (Moderate-resolution Imaging Spectroradiometer), and QuikSCAT (Quick Scatterometer), data can be collected and organized so that the Regional Model can be validated with representations of actual climate events. In order for the observational data to be useful, the meteorological variables, times of observation and exact locations of atmospheric measurements must be acquired from the many different sources. In addition, the different graphical representations of the observational data must be considered as well as their tabulation. As the RM3 is validated and perfected, its accuracy and ability to simulate future atmospheric conditions can be improved. Once the RM3 is ready, it can serve many different functions, including weather prediction for organizations such as ACMAD (African Center of Meteorological Applications for Development). Another function of the RM3, the simulation of soil moisture and surface (or "skin") temperature, would allow scientists to analyze the relationships between meteorological events such as storms and droughts and the environment's ability to produce a substantial crop yield. Most importantly, improved climate and weather forecasts for African countries would help prepare citizens for epidemics of diseases such as meningitis and malaria that occur during the rainy season, as well as economic difficulties from deficient agricultural production associated with drought. Agricultural preparations would help to counteract the specter of long and all too frequent occurrences of drought that have led to famine throughout West Africa.

REGION OF STUDY: WEST AFRICA

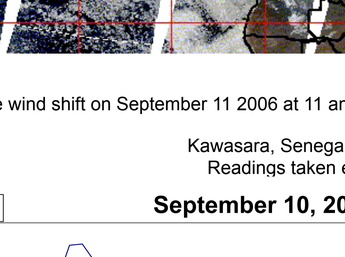




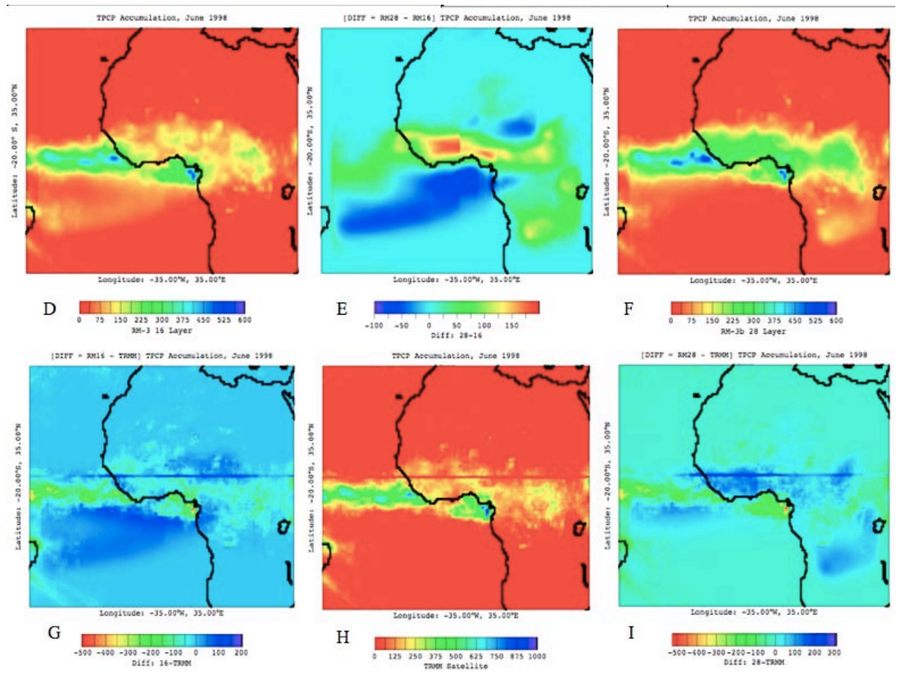
NCEP Reanalysis Boundary Conditions (Starting - Horizontal data)
NCEP Reanalysis Boundary Conditions (Starting - Vertical data)
NCEP Reanalysis Boundary Conditions (Ending - Vertical data)

The diagram to the left illustrates the way a regional model thinks. Based upon boundary conditions surrounding the cube, the regional model computes the data within the inner cube. This simulated output is actually a bunch of numbers stacked on top of each other. Different variables can be outputted such as: Sea Surface Temperature, precipitation, u/v winds, just to name a few…!,

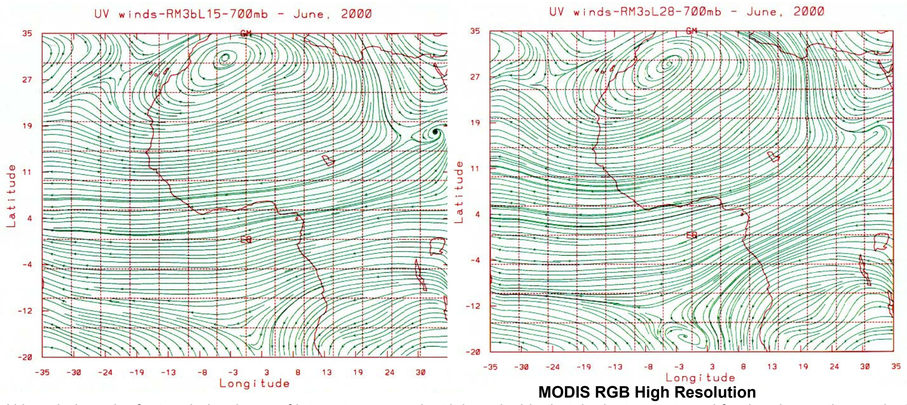
The multi-colored cube represents a picture of how the model is driven by the initial conditions



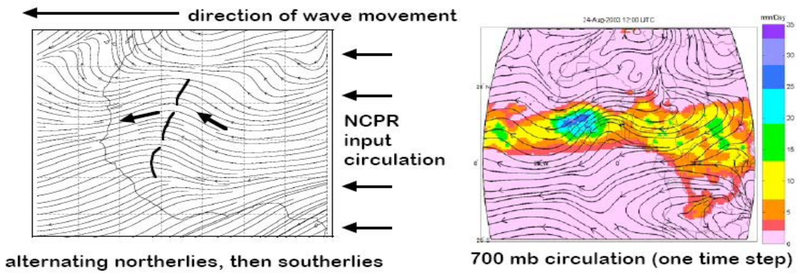
The image to the left is that of the TRMM satellite - a creation of JAXA (Japanese Aerospace and Exploration Agency). The TRMM is used to validate the RM3b simulations. This enables the scientists, Dr. Leonard Druyan and Dr. Matthew Fulakeza to test the models accuracy.



The image above shows that the 28 layer performs better than the 16 layer



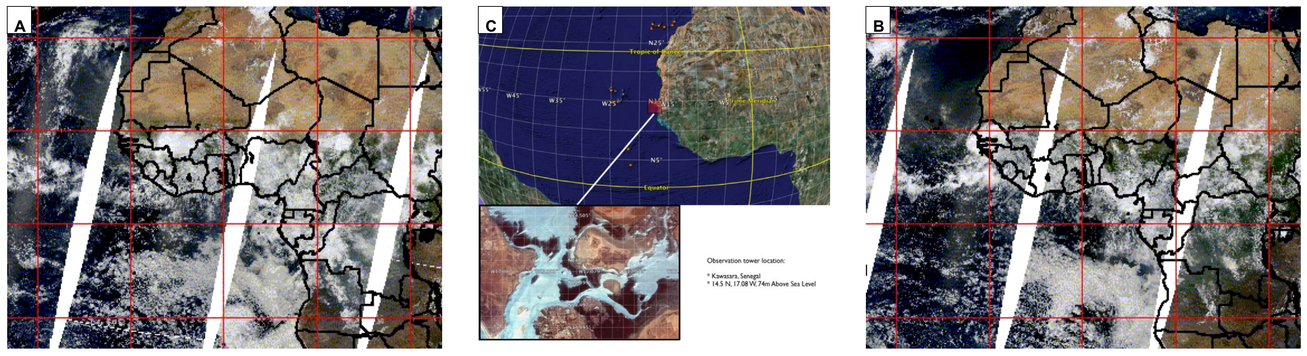
Samples of RM3-28L circulation and precipitation



Meandering circulation shows disruption in the African Easterly Jet at 700 mb (3 km) altitude known as African Easterly Wave
Color plot shows that the highest rate of precipitation is west of the trough line

MODIS RGB High Resolution

Although the color feature below is not of interest to our project it is noticable that the instrument used for the observation on the MODerate Resolution Imaging Spectroradiometers is a combination of.Red, green, and blue channels to represent what your eye would see from this vantage point in space.

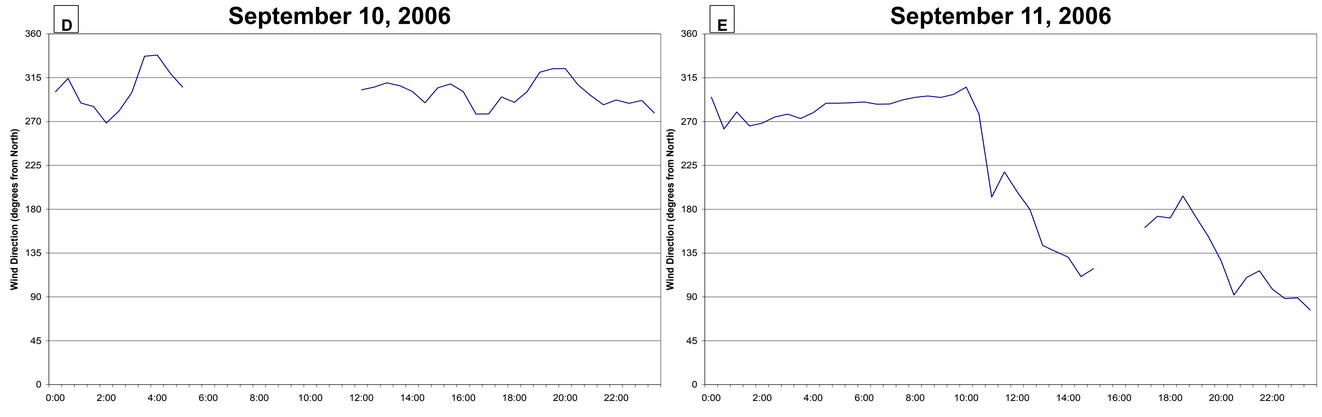


A) MODIS Satellite Image of cloud distribution from September 10, 2006
B) MODIS Satellite Image of cloud distribution from September 10, 2006
C) Location of Data charts below (Google Earth image)
D) Wind Direction at Kawasara, Senegal on September 10, 2006
E) Wind Direction at Kawasara, Senegal on September 11, 2006

*The position of the micrometeorological tower site (C) relative to the storm (A & B) shows consistency with the measured wind direction (D % E).

Note that the wind shift on September 11 2006 at 11 am from west to south east is evidence of the cyclonic storm passing from north east of the station to the west.

Kawasara, Senegal (Latitude:14.5 N, Longitude:17.08 W, Altitude of observation:74m Above Sea Level)
Readings taken every minute from Micrometeorological Tower and averaged to 30 minute intervals



Conclusions

- The RM3 is an accurate model for simulating weather and climate over West Africa
- Simulating wind circulation over West Africa will help scientists study African Easterly Waves and they relationships with storms
- For the RM3 to be improved, it must be validated with observational data

Future Work

- Collecting data from AMMA and NAMMA
- Collecting data from Satellites (TRMM, MODIS, QuikSCAT, SSM/I)
- Validating the RM3 with field observations, satellite data
- Validating the RM3 with WRF
- Animating the TRMM and RM3 simulations
- Posting results on GISS, NAMMA AMMA, WAMME websites

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